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FACTS ABOUT MILK.

BY

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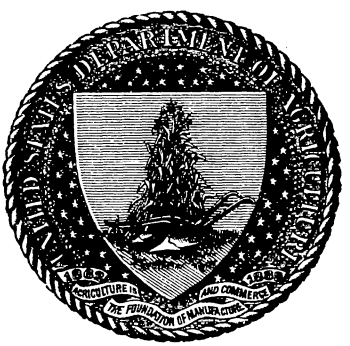

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THE DAIRY INDUSTRY.

The production and distribution of milk and milk products engage the attention of no small part of our population. The use of milk is general and not limited to any class or locality; it is regarded as a necessity by almost every family and for this reason information regarding it is important. In New York, Iowa, Pennsylvania, Wisconsin and neighboring States, dairying is carried on very extensively; in large parts of these States it is the chief occupation of the farmers. In the South and West the number of cows is rapidly increasing. This branch of agriculture is so widely practiced in the United States that this is regarded as the leading dairy country of the world. In 1889 the annual value of our dairy products was estimated to exceed $400,000,000, and the value of the milch cows in the same year was about $370,000,000.

It would be impossible to closely estimate the value of all property devoted to dairying, but it can be safely said that in gross investment it is exceeded by few other branches of industry.[1] There are about 17,000,000 cows in this country, or one to every four inhabitants; one cow, however, furnishes the milk, butter, and cheese for more than four persons, as large quantities of dairy products are exported. Although this is the greatest dairy country in the world it does not lead in the per capita consumption of dairy products; one of the principal reasons for this is the failure of Americans to appreciate the food value of milk and its products. In some of the older European countries two or three times as much milk and cheese is consumed, per capita, as in the United States.

The average milk consumption is high in many parts of this country and, assisted by improved methods of production and transportation, it seems to be increasing. It is estimated that the milk from 5,000,000 cows is annually consumed, as milk, in the United States, the average being about 25½ gallons per year to each person; this means an ordinary sized tumblerful each day. Many use a much greater quantity and consequently the number of those who use little or none must be very large, in order to make this average. Within recent years cream has become an important article of commerce, and in some localities condensed milk is extensively used.

[1] For the statistics of dairying in the United States, see Bulletin No. 11 of the Bureau of Animal Industry (Dairy Division No. 1), Department of Agriculture.

The value of these foods is often much diminished or entirely lost from lack of information on the part of the purchaser—and producer and dealer as well—regarding the peculiar qualities of dairy products and the best methods of keeping and using them.

MILK.

Milk is a whitish, opaque liquid. To the ordinary observer it appears to be a perfect solution, and is commonly regarded as such, being bought and sold by liquid measure, but when placed under the microscope it is seen to consist of a clear, transparent fluid containing many minute globules of various sizes (fig. 1*b*). The fluid part, called the milk serum, consists of water and all the other constituents of milk except the fat, and these other constituents, although solids when separated and dry, are practically all dissolved in the water, or, as is said, in solution. The globules are little bodies of pure fat scattered through the serum and not dissolved; they are semisolid and form with the serum a mixture called an emulsion.

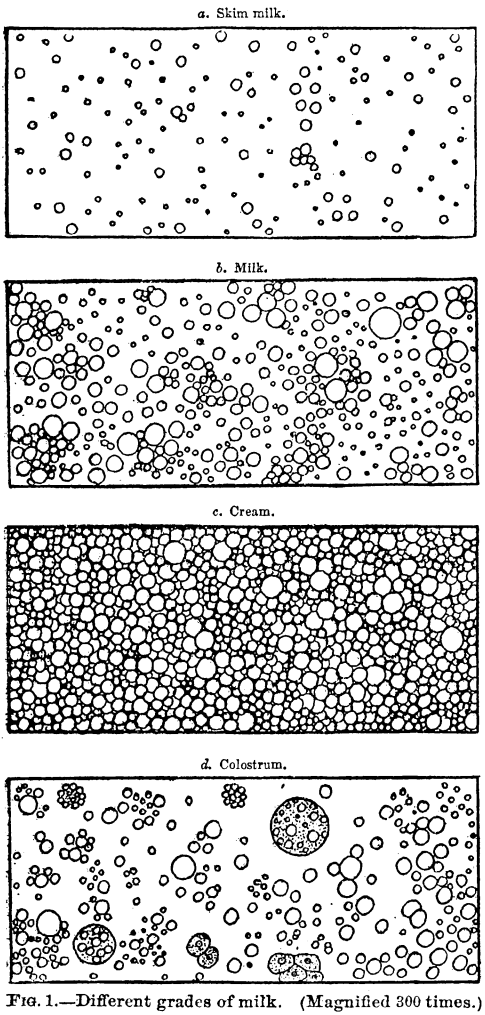

FIG. 1.—Different grades of milk. (Magnified 300 times.)

The solid constituents present in the serum in largest quantity are sugar and casein; albumen and mineral matter are present in small quantity, and there is also a little fibrin resembling the fibrin of blood. There is more sugar in milk than any other solid component, but it is in solution. This milk sugar can be separated and brought into solid form; as sold, it resembles powdered white sugar. It is used to a considerable extent by druggists and in some food preparations, but is not as sweet as cane sugar and its commercial value is not sufficient to induce its manufacture in large quantities. It is the sugar which undergoes the greatest change when milk becomes sour. The casein and albumen of milk are its

nitrogenous constituents and are comparable to the white of an egg. Acid or rennet causes casein to coagulate, forming curd and, as such, it is one of the chief ingredients of cheese, constituting about one-fourth of that important food. The mineral matter in milk, called ash or salts, is the indestructible part that remains when milk is evaporated to dryness and burned; this consists chiefly of phosphates and chlorides of soda, potash, and lime.

It is well known that when sugar is dissolved in water the solution is less limpid than pure water, and if many small bodies a very little lighter than water were thoroughly mixed into the solution their rise would be more or less retarded by the stickiness of the surrounding fluid. Milk might be compared to a thin sirup with many fatty and light particles floating in it, as just described. It is viscous or sticky, because of the solids held in solution, and this viscosity, together with fibrin, has a considerable effect in retarding the rise of the fat globules and the formation of the cream layer. The older milk is, the more effective are these forces. The fat globules are so small that a single drop contains many millions of them. It is said that if a person should attempt to count the globules in a drop of milk it would take ten years of his time, provided he counted at the rate of 100 per minute and worked ten hours per day six days every week. Such a number is too large to be appreciated. The globules average about one ten-thousandth of an inch in diameter, and twenty-five of average size placed side by side would about represent the thickness of ordinary writing paper. Globules of different sizes are found in the milk of any cow, but with certain breeds the size is uniformly larger than with other breeds. The milk of Jersey and Guernsey cows has this peculiarity, which explains why the cream rises so readily on it and why the skim milk is so thin and poor, large globules naturally being able to get to the top more quickly than small ones, many of which can not rise at all.

COMPOSITION.

One hundred pounds of good milk contain about the following amounts of the different constituents: 87 pounds of water, 4 pounds of fat, 5 pounds of milk sugar, 3.3 pounds of casein and albumen, and 0.7 pound of mineral matter or salts. These proportions are graphically shown by fig. 2 on the next page.

These constituents vary between wide limits; the total solids of milk may be as low as ten or as high as eighteen parts in one hundred. This variation is due to several causes, some of which are given later. The fat varies in quantity more than any other part of the milk, running as low as two parts in one hundred and as high as seven; the larger the proportion of fat the richer is the milk. Most of the States and many cities have a legal standard for the composition of milk, and any falling below this standard is legally regarded as adulterated although it may

be, in fact, the pure and natural product. The laws usually require 3 or 3½ per cent of fat, and 9 or 9½ per cent of "solids not fat." (This term is commonly used to designate all the solid substances of milk other than fat.) The "total solids" required thus vary from 12 to 13 per cent, according to different laws, which means, of course, that in every 100 pounds of milk there shall be 12 or 13 pounds of solid matter. These legal requirements are justified by the fact that it is the solid matter and not the water which gives value to milk.

The fact that the standard so often relates to the proportion or percentage of fat and the popular impression that milk is without value after the cream has been removed, lead some people to think that fat is the only valuable part of milk. This is a great error, as casein

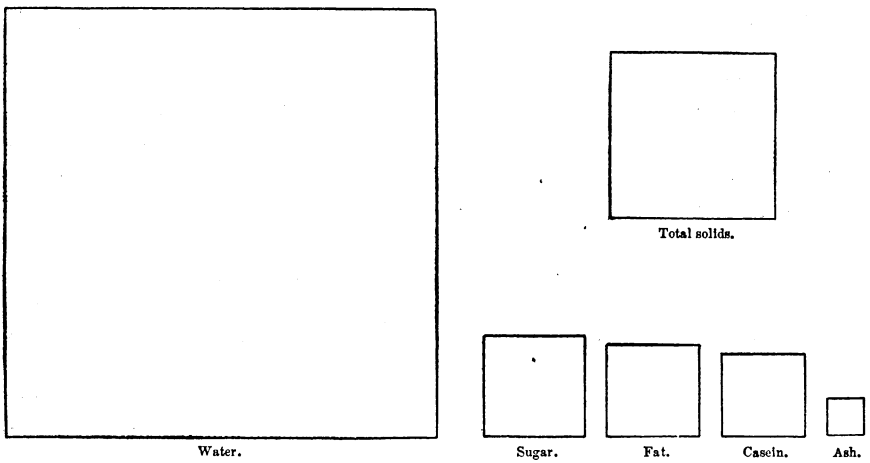

FIG. 2.—Proportions of the component parts of milk.

is one of the cheapest forms in which such food can be obtained and is more nutritious than similar compounds in most other foods. It is, however, safe to judge of the quality and value of milk by the fat it contains, because the greater the portion of fat the greater is the quantity of the other valuable parts or "solids not fat."

CAUSES OF VARIATION IN THE COMPOSITION OF MILK.

The proportion of constituents in milk depends largely upon the kind of cows. Jerseys and Guernseys, by some people incorrectly called Alderneys, produce a rich milk, on which the cream rises quickly and completely; this is a decided advantage to those who wish to raise cream, but not if the milk is to be used whole. It may be a positive disadvantage, in some cases, to have the cream separate too soon. Durham and Ayrshire cows give milk of an average quality from which the cream rises slowly, and on this account they are sometimes said to be good "milkman's cows." Holstein milk usually has a small proportion of fat or cream, but some families of these "black and whites"

supply a product of excellent quality. The Holstein cows are noted for producing enormous quantities of milk.

Although these statements refer to pure-bred cows of the different breeds named, they also apply to grade animals having one-half or more of the blood of these breeds. All cows of the same breed do not give milk of the same quality; in fact, the composition of milk from cows of the same breed may vary as much as that from cows of different breeds. As a rule, however, similarly bred cows, under like conditions, give about the same quality of milk at corresponding times during the period of lactation. It is a popular notion that the feed given a cow influences the quality of her milk more than anything else; but if a cow in normal condition gives a rich milk at one period her milk will be of good quality at all times, unless she is badly neglected or diseased. Feed has a much greater influence upon the quantity of milk produced than upon its quality.

The first milk given after calving is called colostrum (fig. 1, d). It contains a large proportion of albuminoids and is somewhat laxative. It is not fit for food, except for the newly born. In natural milk a small amount of albumen is present, but in colostrum the albumen often exceeds the amount of casein, and these two constituents may form over 15 per cent of the milk. The percentage of sugar in colostrum is usually low; the fat is normal. The composition of colostrum changes rapidly, and within a few days after birth of the calf natural milk is given. After this the percentage of fat in the milk from any cow varies more or less from day to day, even if her feed, care, and general treatment are always alike. The causes of the sudden changes are not always known; in fact, the fat often seems to increase or decrease without any cause. Sometimes the fat content changes over 30 per cent within twenty-four hours. As the period of lactation progresses there is a tendency to gradually increase in the total solids and the physical condition of the milk is so altered that cream rises less easily.

In well-regulated dairies each cow is milked about ten months of the year; the remainder of the year she is said to be "dry." When a dairyman takes the product of his herd to a cheese factory it is the custom to have all the cows giving milk in the summer time and none in winter, but when he supplies milk to customers he endeavors to have a small part of the herd dry at a time, so there will always be enough cows in milk to supply his trade. An incidental advantage of this is, the milk from fresh cows is added to that from those more advanced in the milking period and the changes due to the time of lactation are avoided in the mixed milk, which is thus kept of uniform quality.

DIFFICULTIES IN OBTAINING PURE MILK.

The first thing to be borne in mind is that milk is naturally a pure product. If any milk is found unclean, unwholesome, or disproportioned in its proper parts, the chances are that it is not the fault of the

cow. In all such cases the presumption is that some person is to blame, either the one who cares for the cow or the one who handles the milk. If those who buy milk used proper care they would have little trouble in always procuring a good clean article. It is possible to produce milk free from contamination, and if impure milk is delivered the dairyman or dealer may be held responsible, and it is the duty of the customer to reject it. When the milkman knows that his customers will not accept poor or unclean milk he will stop offering it.

On the other hand, some people are most unreasonable in their complaints and demands upon their milkmen. This, and the sharp competition between rival dealers, are two chief causes of dishonesty in the milk business. When a milk peddler knows that he is delivering the best of milk and complaint is made that it is not yellow enough or has not enough "body," and he is afraid of losing a good customer, he is naturally tempted to either give that person a supply from near the top of a can, thus depriving some one else of cream which rightly belongs to him, or to do what he thinks his dishonest competitor is doing, whatever that may be. There is a great desire to get milk cheap, and it is not an unknown thing for customers, including hotels and private institutions as well as private families, to demand such large measure for their money that the dealers feel compelled to "extend" the milk in order to meet these requirements and prevent loss of trade. Some are satisfied with the adulterated stuff, not knowing that the same amount of actual food, but no more and perhaps less, is being delivered in the large measure than was formerly delivered in the small one. This explains how it sometimes happens that milk is retailed in cities at less than the regular wholesale price. People too easily forget quality and think only of quantity. The only sensible thing for the housekeeper or other buyer of milk to do, is to willingly pay a fair price and insist upon good milk in return. Buyers should remember that at the highest prices usual anywhere, good milk is about as cheap an article of food as can be purchased.

It should also be borne in mind that milk can be contaminated as easily after delivery to the family or consumer as before, and too often a milkman is blamed for bad milk or cream when it was made so by conditions over which he had no control. If left where dust can settle in it or flies have access to it, or if set in an ill-ventilated cellar or in a warm place, it is pretty certain to be in bad condition after a few hours, no matter how good it was when delivered.

Numerous well-authenticated cases are known where customers have complained of milk received, and upon investigation it has been proved that servants in the house tampered with the milk, removing cream for their own use or adding old milk or vinegar to make it sour prematurely. The object of the latter act was, in connivance with an outsider who supplied the motive, to cause the buyer to change to some other dealer whom the servant was ready to recommend.

Attention on the part of consumers to the proper way of producing and handling milk would result in a great improvement in this most important food. Laws will do much to prevent fraud, but customers who know exactly what they want, how to get it, and how to care for it, have a much greater effect on milk producers and dealers than any possible laws.

CHANGES OF MILK.

Pure as milk may be in its natural state, it is a perishable product, and although with a proper knowledge of its peculiarities and care in its keeping it can be held in a wholesome state a reasonable length of time, there are natural changes which are sure to occur as soon as opportunity is given. Thunderstorms, impurities, warm temperature, and other conditions known to exist when milk is most liable to give trouble have been blamed for its changes. But it is now known that these are only indirect causes, and that the changes in milk which bother the housekeeper are due to, and can not take place without, the presence of minute organisms called bacteria. The souring of milk and other fermentations have been discussed in Farmers' Bulletin No. 29, issued by the Department of Agriculture. This bulletin describes the bacteria and various fermentations of milk, including the common changes and those which cause it to become blue, bitter, slimy, or ropy, and treats of the practical bearing of the subject upon dairying.

Any milk having a large amount of sediment is suspicious. Particles of dirt are a sign that germs are abundant. Thus dirty milk may be dangerous as well as disgusting. The dirt in milk consists mostly of particles of dead skin and manure, which fall into the pail from the body of the cow during milking; but dust in the stable, and dirt and dust in the vessels used for handling milk, and unclean attendants, are also common sources of dirty sediment in milk.

Milk from unhealthy or unthrifty cows or that which has been handled by sick persons is dangerous, as it may contain infectious germs or foreign substances which might affect the health of the consumer. The germs of typhoid fever, scarlet fever, diphtheria, and consumption (or tuberculosis) have been found in milk, and thus transmitted to man, and spread from family to family. Feverish cows, those having just given birth to a calf, and sometimes cows that have been milked a long time, produce milk which should not be used. Any milk having an unnatural appearance should be discarded.

Odors and peculiar flavors are due to bacterial action or to the volatile oils of some foods; onions, turnips, cabbage, and certain weeds, as garlic and wormwood, give characteristic odors and tastes to milk.

ADULTERATION.

The most common forms of fraud practiced with milk are the removal of a part of the cream and the addition of water. Color is sometimes added, but the addition of chalk, burnt sugar, salt, or other substances,

although often charged, is in fact quite rare. The mixing or blending of milk means that good milk is mixed with poor milk to obtain an average quality. Sometimes skim milk is mixed with a lot of good quality to make a medium grade; this practice amounts to exactly the same as removing a part of the cream. Most communities have laws against adulteration, but they are not always rigidly enforced. Adulterated milk is unsafe, as it contains less food value than it should have, and the consumer is deprived of nourishment which is supposed to be given. But this is not the worst about milk that has been adulterated by water. If a dairyman is dishonest enough to water his milk he will probably not be careful about the purity of the water added. Impure water contains many bacteria. Most of them are perfectly harmless, but in such an immense number there may be some dangerous species, such as disease germs and bacteria producing changes in milk which cause diarrheal disturbances. Epidemics of contagious diseases have been traced directly to contaminated water added to milk for the purpose of adulteration, or which had been used to rinse the cans.

PRESERVATIVES.

Various chemicals are sometimes added to milk to prevent its souring, but while a few advocate their use the weight of opinion is against them. The most common substances contain salicylic acid, boric acid, borax, or formaldehyde. These are not regarded as poisons, but when taken regularly in small doses in milk they may have an injurious effect on the system. They, or mixtures of which they form a large part, are sold under many different names, and are sometimes used in canned fruits and vegetables. Boric, or boracic, acid is more powerful in its physiological action than borax; both are strong antiseptics. Salicylic acid is a white crystaline powder, that is odorless and tasteless. It was once used so extensively in France that fears were entertained lest it would have a detrimental effect on the public health, and a commission was appointed to investigate its action. The report stated: "The addition of salicylic acid or its derivatives, even in the most minute amounts, to foods, solid or liquid, should not be authorized." The United States Dispensatory says: "Salicylic acid has been used for the preservation of various articles of food, but the employment of it should be interdicted." Formaldehyde is a powerful germicide, and it is asserted that it has an adverse effect on the digestibility of casein. The use of these substances is now prohibited by law in some States and in numerous cities. Small continued doses of them do not affect many people, but serious symptoms may be developed in some, and no one can tell who might have this idiosyncrasy. Salicylic acid and its salts are eliminated by the kidneys, and as these organs become less active in the aged they feel the effects more than the young. It is easily seen that in the same way in which preservatives prevent the natural changes of milk they may prevent its digestion in

the stomach, the process of digestion being similar in some respects to the fermentations. The danger from their use would be much less if they were handled only by intelligent persons; a very small amount is sufficient to prevent milk or cream from souring, but an ignorant person is likely to think that if a little is good, more would be better, and so use much more than necessary. Another objection to chemical preservatives is that one accustomed to their use may get in the habit of depending on them so much that he would use even less care with the preserved milk than if it were not preserved.

CARE OF MILK.

The proper care of milk after it has been delivered to the consumer is a matter of great importance. It is desirable to have it in the best condition possible for use, and it is not desirable to blame the milkman for things for which he is not in the least responsible. If milk is kept in an open vessel in a refrigerator with meats and various kinds of vegetables, it will absorb odors from them. It is also sensitive to flavors, and if allowed to stand in an old tin dish the "tin taste" can easily be recognized. Milk should therefore be kept in a cool place, free from odors, and in a perfectly clean vessel of suitable material. A well-glazed earthen or porcelain dish, or a glass jar or bottle, is the best container; tin is good so long as bright and the iron is well covered. Wooden dishes are objectionable.

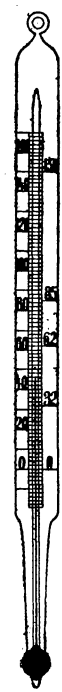

FIG. 3.—Dairy thermometer.

As already stated, the change to which milk is most liable is simple souring, and the best agents to prevent this change are cold and heat. There should be no trouble in keeping milk sweet at a temperature of 50° F. from twenty-four to thirty-six hours after it is in the hands of the customer. But this can not be done unless it is delivered in good condition and properly handled after delivery. It is the custom in some places to leave the milk in dishes on the doorstep early in the morning, and it often remains there exposed to heat, dust, insects, and small animals until wanted in the house. This is a bad practice. In hot weather, milk exposed in this way for any length of time should soon sour, and if it does not it is probably due to the presence of preservatives. Too much care can not be used in seeing that the milk is cold when delivered, and that it is then immediately put into a cool place. If allowed to stand in the warm air, even for a few minutes, the time it will keep sweet is shortened. Of course it will keep longer at a temperature between 35° and 50° F. than above 50° F.

Sometimes milk does not keep sweet when no cause can be discovered for its souring. This is frequently the case in summer. Often the trouble is the refrigerator, which may seem cold on account of the great difference between its temperature and that outside, while it is, in fact,

not cold, and a thermometer may show its temperature to be even above 60° F. A floating dairy thermometer (fig. 3) is a convenient article to have in the house. It is a closed glass tube with a paper scale inside; it can be put into a fluid without injury, stands upright in the liquid, and is easily cleaned. The temperature of the milk should occasionally be taken when it is removed from the ice chest and the cause of early souring may be found.

PASTEURIZATION.

Pasteurization of milk is now being extensively practiced, and it is found to be an especially good means of preservation when it is difficult or too expensive to keep the milk at a sufficiently low temperature to prevent souring until wanted for use. A large proportion of the germs are killed by heat. When sufficient heat is used to kill all the germs the product is called sterilized milk, and may be kept in good condition indefinitely.

The advantages of pasteurized or sterilized milk are several, the most important being the destruction of some or all of the germs which may be present. For this reason alone it is thought advisable by some, to use heat whenever the source of milk supply is not known, or when any epidemic is in the community, and some even recommend that all milk be boiled before it is used. If for any reason it is desired to keep milk longer than usual, as for a sea voyage, pasteurization will be a great help. There are some disadvantages in pasteurizing or sterilizing milk. If a sufficient degree of heat be used to kill all infectious germs a scum appears on the top, which is the albumen of the milk coagulated by heat; besides this, a boiled taste is acquired, which is objectionable to some persons, though very pleasant to others; and milk thus treated is found to be a little less digestible than raw or natural milk. If a high degree of heat be used, the sugar is scorched and forms a brown deposit in the bottom of the vessel. An advantage of pasteurizing at home, if it is advisable to do this at all, is that one knows better the quality of the milk he gets, as it is easier to judge milk while fresh than when cooked.

The pasteurization of milk is an extremely easy operation, and if mothers better appreciated the dangers to which their little ones are exposed from the use of raw milk from unknown sources, especially in the summer time when it may be teeming with bacterial growth, more of them would use this simple precaution. It is estimated that one-third of all children die before they are three years old, and one of the leading causes of infant mortality is unwholesome milk. Bad milk can not be made perfect by pasteurization, but the danger from its consumption can be lessened. This Department has issued circulars giving full directions for pasteurizing milk in small quantities. The process is very simple and the necessary apparatus is inexpensive.

Briefly, the directions are as follows: One or more bottles nearly full

of milk are plugged with dry absorbent or other clean cotton and placed in an upright position in a vessel having a false bottom and containing enough water to rise above the milk in the bottles (fig. 4). The vessel is closed, placed on the stove and heated until the water is 155° F., if in winter, or to 180° (or even to boiling if special precautions are deemed necessary) in summer. It is then removed and kept tightly covered for half an hour. A heavy cloth over the pail will help to retain the heat. The milk bottles are then taken out, cooled as quickly as possible by cold water or ice, and kept in a cold place. Milk thus prepared may be expected to keep twenty-four hours, and should preferably be used within that time. The cotton plugs should be kept as dry as possible and should not be removed until the milk is to be used. A covered tin pail answers well for the larger vessel. An inverted pie pan with perforated bottom can serve as the false bottom. A hole may be punched in the cover of the pail, a cork inserted, and a chemical thermometer put through the cork so that the bulb dips in the water, thus enabling one to watch the temperature closely without removing the cover, or an ordinary dairy thermometer may be used from time to time by removing the lid.

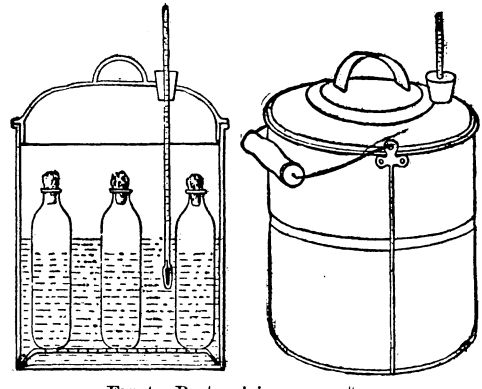

FIG. 4.—Pasteurizing apparatus.

CREAM.

When it is desired to raise cream the milk should be put in a cold place, where it will not be disturbed, as soon as possible after it is received. A good quality of cream for table use can usually be obtained in this way (see fig. 1, *c*). It will aid the cream in rising if the temperature of the milk is raised to about 100° F. and then lowered by placing the dish in cold water. This can not be done unless the milk is in good condition, as the high temperature may cause it to sour before it can cool sufficiently to prevent souring. Milk jars or bottles are now extensively used, and if they are filled when the milk is fresh, and carefully carried, the cream will begin to show in a few hours, and much less time is required for it to reach the top after it has been delivered than when it has been mixed just previous to delivery. Thus by the use of the jars considerable time is saved and fresher cream can be obtained. The jars may be purchased from any dairy supply company at a small cost, and provide a neat, clean way of handling milk.

Separator cream can be made much richer than "gravity" cream, and for this reason is preferred for whipping. It may be kept longer

than that raised by gravity as it can be taken from perfectly fresh milk, while the latter is usually twelve to twenty-four hours old when skimmed. Cream gradually becomes thicker the longer it is kept, and it is often held for this purpose. Sometimes it is one or two weeks old when used; very little is used in as fresh condition as milk. For this reason special care is needed to keep it sweet. Satisfactory results are not obtained by placing it in a refrigerator at a temperature of 50°. It ought to be kept as near the freezing point as possible; it should be placed directly on the ice, or, better yet, be *entirely surrounded* with ice. Good efforts will be wasted if the ice comes up only halfway and the top part is exposed to a warm temperature—it must be cold throughout. Skimmilk and buttermilk should have the same care as whole milk.

DETECTING IMPURE MILK.

Some of the more common forms of impure milk have already been noted. By pure milk is meant the properly handled product of healthy, well-fed cows. To be legally regarded as pure, in some places, milk must contain at least a certain amount of fat and other solids. It is a difficult thing to determine by the appearance of milk whether it is pure or not, and even experienced dairymen are frequently unable to do this. It has a slightly yellowish white color, a very slight odor, if any, and should have a distinctly sweet and pure taste. When allowed to stand quietly for several hours, cream should rise naturally, and if the separation is thoroughly effected the cream should form one-eighth to one-fifth of the total volume or bulk. No sediment should appear in the bottom of the jar or vessel. When good milk is poured from a tumbler it should cling to the glass a little and not run off clean like water. Skimmed or watered milk is thinner than whole milk and of a lighter shade, being a bluish-white color. The yellow shade of milk is chiefly due to its fat, but as this constituent is more yellow in the milk of some cows than others the yellowest milk is not necessarily the richest, and it is unsafe to judge by the color alone; poor milk from some cows may be more highly colored than rich milk from others. Besides this, artificial colors are sometimes added by dishonest persons.

When a volume of milk is to be tested, the first and most important thing to be done is to obtain a fair sample—one that will represent the whole and show its average composition. If the sample is taken from near the top or bottom of a vessel of milk which has been standing quietly for even a short time, it will be too rich or too poor in fat. The milk must be well and thoroughly mixed before the sample is taken. A good way of doing this is to pour it several times from one vessel to another. This should be continued until it is homogeneous and no lumps appear on the surface. If small particles of butter are floating about, a fair sample can not be taken. There are several methods of testing milk. A complete analysis by a chemist

will give the exact amount of each component part. This requires considerable time and expense, and is not necessary for practical purposes.

CREAMOMETER.

A very simple test, and one which, although not altogether reliable, is better than none, is the judgment of milk by the amount of cream it will show. This is not an accurate test, because it may fail to show cream when it should or it may show more than it ought; however, it will not show cream if there is none in the milk. With two samples of milk having the same amount of fat different results may appear with this test, as the proportion of the fat globules which rise, depends somewhat on the age of the milk and the way it was handled before delivery. If fat globules have much difficulty in rising, only a small part of them will get to the top and they may carry up with them so much of the other constituents that there will be a large bulk of poor cream. When the test is carefully conducted and conditions are favorable to the rise of cream, fair results can usually be obtained. This test requires a long, graduated glass tube (fig. 5), which is filled with milk to the zero mark and allowed to stand in a cool place for twenty to twenty-four hours. The cream is aided in rising by warming the milk to 100° F. and then setting it, in the tube, in cold water, or the tube may be filled half full of milk and the remainder with warm water, which raises the temperature and reduces the viscosity; in such case only half as much cream will appear as the milk is to be given credit for; for example, if the contents of a glass are half water and show 10 per cent cream upon the scale, this means, of course, 20 per cent of the milk. If the milk is the same each day and is tested in the same way, there should be little difference in the cream shown. Tubes graduated specially for this test are sold by dairy-supply firms. The cream test furnishes a good opportunity to look for sediment; if the milk is not clean, dirt can be seen in the bottom of the cylinder. Care should be taken to carry the tube quietly, so that neither the cream nor the sediment will be disturbed.

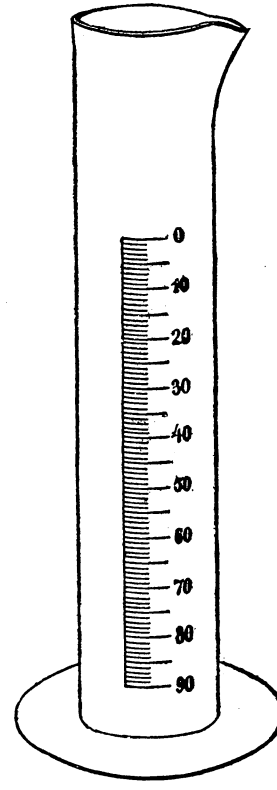

FIG. 5.—Creamometer.

LACTOMETER.

Milk is a little heavier than water. Its specific gravity varies from 1.029 to 1.033, and departures from the standard, due to the quality of

the natural milk or to skimming or watering, can be measured by an instrument called the lactometer. This is a weighted glass bulb with a slender stem, bearing a graduated scale, and it is so adjusted that when placed in pure milk it will sink until a point on a certain part of the scale is even with the surface of the liquid. Different kinds of lactometers are graduated in different ways. A style frequently used registers 100 when the specific gravity is 1.029, and less than 100 when the specific gravity decreases. A specific gravity of 1.033 would be indicated by 114 on this lactometer. The Quevenne lactometer (fig. 6) has a thermometer inclosed in it and gives directly both the specific gravity and temperature of the milk being tested. This is a convenient instrument, as the lactometer gives true results only when the thermometer stands at 60° F. Accurate as these instruments are, they can not do more than show specific gravity. If cream, which is lighter than milk, is removed, the specific gravity is increased, and if water is added, the specific gravity is decreased. Therefore, if a sample of milk has a high specific gravity, skimming is suspected, while if it has a low specific gravity watering is suspected. But if some cream is removed and water added in proper proportion, the specific gravity may remain unchanged, and just this is one of the commonest ways of all for adulterating milk. Such fraud can be detected, however, by another test in connection with the lactometer, which depends upon a certain relation existing between the amount of fat in milk and the total solids. This relation is considerably changed when milk is skimmed and watered, as water is used to replace fat. This test, however, involves mathematical formulæ and can not be well described here.

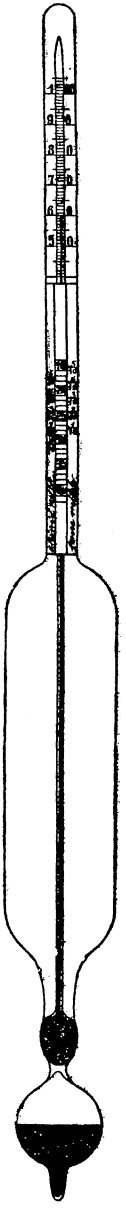

FIG. 6.—Lactometer.

A fair opinion of the value of milk, so far as its composition is concerned, can be formed from the percentage of fat, as the total solids of normal milk increase and decrease as the amount of fat is greater or less. If milk has been tampered with by watering, the percentage of fat is reduced in the same proportion as the other constituents, but in a greater proportion if the milk was skimmed. As fat is the part that the dishonest person tries to abstract, the purchaser is on the safe side if he judges of the quality of the milk by the fat which it contains. Many tests for the fat of milk have been proposed. The lactoscope and other optical methods are sometimes used to determine the "oil," but they are inaccurate, and especially so in the hands of one without large

experience. Some of them depend on the color of the milk or on the fact that the more fat there is, the less light will pass through a thin layer. But as the color of milk is not an indication of its richness, and the same amount of fat will retard more light when in small than when in large globules, these methods may give incorrect results, and are therefore unreliable.

BABCOCK TEST.

Several methods of rapidly determining the fat content of milk with the aid of chemical reagents have been devised. One of the most accurate is the Babcock milk test.[1] The little machine constructed to apply this test, and of which several patterns are made, is in use in almost all well-conducted milk-receiving stations. It requires about a tablespoonful of milk for a sample, and the exact percentage of fat in it can be determined by this test in ten or fifteen minutes. The result is obtained by the action of centrifugal force combined with some chemical effects. The original cost of the machine is from $3 to $15, according to size and pattern, and a few cents' worth of materials are used at each operation. Its manipulation is easily learned, and it can be successfully operated by any careful person. A definite amount of the milk or cream to be tested is measured in a pipette and placed in a bottle which has a long, slender, graduated neck (fig. 7); sulphuric acid is then added, and the bottle shaken until the mixture becomes dark colored, which requires but a few moments.

The bottle is then placed in the machine, by which it is rapidly revolved in a horizontal position with the neck toward the center. The fat is thus forced toward the neck by the other contents of the bottle, which are heavier and therefore thrown away from the center to the bottom of the bottle. Sufficient warm water is added to bring the fat up into the neck, where its exact percentage can be read on the scale. In the illustration a pipette for measuring the milk, the acid measure, and a test bottle are shown. From two to twenty-four bottles, containing as many different samples, can be tested at a time, according to the size

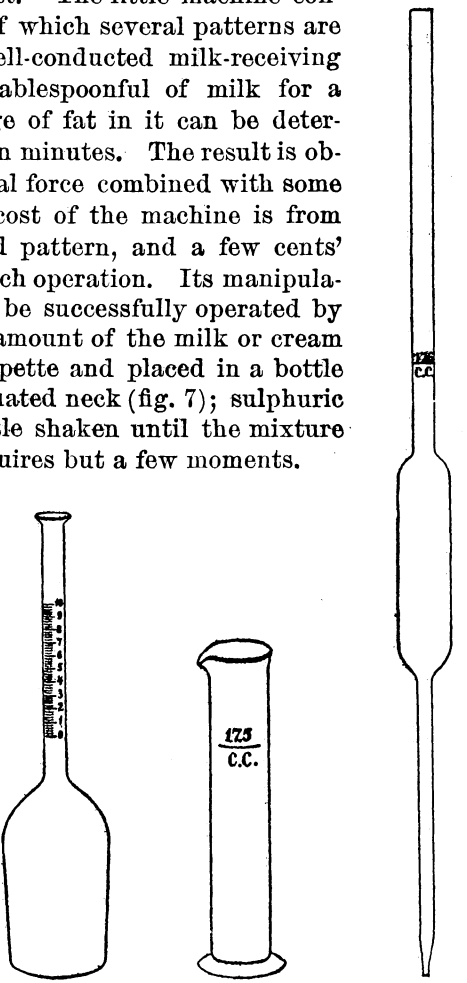

FIG. 7.—Glassware for the Babcock fat test.

[1] Invented by Dr. S. M. Babcock, of the Wisconsin Agricultural Experiment Station, and fully described in bulletins of that and several other experiment stations.

of the machine. Special bottles of a modified form are furnished for testing skim milk and cream. Apparatus for this test is sold by dairy-supply firms. A small machine, complete with the necessary glassware and acid, can be obtained for $4 or $5. Full directions are sent with the apparatus. These can be easily followed and quite accurate results obtained after a little practice.

A number of other tests which can be quickly and easily made have been described by different investigators. Like the Babcock test, they are for the determination of the fat only, but are less satisfactory. Some testing appliances have been placed on the market with the necessary chemical agents in bottles designated by a letter or number, without information as to the character of the liquids. These have to be used without sufficient knowledge of their nature, and they are expensive. Ether is sometimes sent out in this way. This is not a safe practice, as considerable damage might result from an inexperienced person handling such a highly inflammable or explosive substance.

If the honesty of a milkman is questioned and much depends on the richness of milk brought by him, it would certainly be a good investment to have one of these instruments on hand for determining fat and it should occasionally be used. Some new test that would show within one-half of 1 per cent the correct fat content of a sample of milk, which required only cheap apparatus and reagents, not dangerous even in the hands of an ignorant person, and which could be operated with little labor, would be most welcome to housekeepers.

ACID TEST.

Acid commences to form as soon as milk is drawn from the cow, and after a certain amount has been developed it becomes evident to the taste and the milk is said to be sour. It is sometimes desirable to know whether milk is near the souring point or not or if it is fresh enough for the use of a baby or delicate person; indeed, this may be a matter of considerable importance, and sometimes causes much uneasiness. It is well known that milk which is almost sour will coagulate on boiling, but this test does not show whether the amount of acid present is small or great. Prof. E. H. Farrington, of Wisconsin, has devised a simple method for determining the amount of acid. Tablets containing a definite quantity of alkaline material (such as caustic potash or soda) are dissolved in water and added to a measured amount of the milk to be tested. The tablets contain a little phenolphthalein, which is colorless when in acid solution and pink when in alkaline solution. A solution of these tablets is slowly added to the milk and the mixture is stirred until it becomes pink. It is then known that enough alkali has been added to neutralize the acid in the measured amount of milk and the amount of solution required indicates the acidity of the milk.

Perfectly fresh milk contains very little acid and would turn pink by the addition of a small amount of alkali, while milk nearly sour

contains more acid and would require much more of the solution to turn it pink. The tablets are made of such strength that if a solution of two of them turns one ounce of milk pink, that milk should keep a certain length of time with proper care. If the milk remains white after the solution has been added to it, it will probably soon sour. This is a very simple, inexpensive, and useful test, and requires only milk enough to fill an ounce bottle. If this test were adopted for household use one could soon ascertain how much of the alkaline solution would be necessary to turn a definite amount of milk pink, at the time of delivery and then refuse any not up to the standard.

It has been already stated that colostrum, or the first milk given after calving, contains a large percentage of albumen, and should not be used for ordinary purposes. Albumen is coagulated by heat, and when colustrum is boiled a large coagulum is formed. If perfectly sweet milk coagulates on boiling, the indications are that it contains too much albumen and it should not be used.

The tests referred to above are all good so far as they go, but none of them show whether the milk is from healthy cows or whether it has been contaminated by germs of disease. The adulteration of milk may produce bad results by diminishing the food value, but intelligent persons will learn sooner or later that they are being cheated, especially if the practice is carried on to a great extent. By far the greatest amount of harm that is produced by milk is due to objectionable bacteria which it contains. An inconceivable number of these organisms may be present in milk and their presence not be noticed, and the only way in which they can be detected is to note the changes of the milk or have a bacteriological examination made, which involves time and expense. No test has been devised that will quickly and easily show the presence of disease germs in milk. It was stated above that bacteria get into the milk of healthy cows after it is drawn, and the best way to keep them out is to avoid, as much as possible, exposing the milk to them. This means that the dairy and its surroundings must be clean, and clean all the time. Filth can not be present in any degree without having a contaminating influence.

SELECTION OF DEALER.

Undoubtedly the best way to secure a good milk supply is to deal with a dairyman or milkman who is thoroughly honest and scrupulously clean. He should be required to show quarterly certificates from a veterinarian of good standing, stating that after a careful examination of his cows they were found to be healthy, that if the health of any was doubtful such animal had been removed from the herd, that the quality of the feed and water, the sanitary conditions of the stables and surroundings, and the health of the employees were approved. His own honesty and experience should be sufficient guaranty as to good measure and quality and that his milk has been properly cared for and

guarded against exposure. The certificate of the veterinarian should be sufficient guaranty as to the good health of the herd and correct sanitary conditions of the establishment. It is a mistake to consider that milkmen are naturally a lot of tricksters. Honest men are in this business as well as any other, and one of the most important steps toward securing honest milk is to encourage the honest man by giving him deserved trade.

Laws have been in force for many years in some of our cities requiring a certain composition of milk as the minimum. These regulations are undoubtedly a great benefit so far as they go, but in many towns and cities there are no such laws in force, and in order to secure a good quality of milk the great majority of milk consumers rely on the intelligence and honor of the one who supplies them. One of the best incentives for a dairyman or dealer to keep his dairy as it should be, is to feel that he may expect a visit at any time from some of his customers. The practice, which seems to be growing among consumers, of occasionally visiting the farms and stores from which their milk comes, can not be too highly commended. When one does this he should take special care to know that he is not visiting a sample farm which is always kept ready for inspection, while others, perhaps more distant, are not in such good condition. His milk *may* come from those more distant. On a well-conducted dairy farm one may expect to find these conditions:

A roomy, clean, dry, light, and well-ventilated stable or cow house. To produce good milk cows must be comfortable, and these conditions not only add to their comfort, but are absolutely necessary to keep them in the best of health.

Healthy and clean cows, which appear well-fed and contented.

An abundance of pure water to which cows are given access at least twice a day.

Feed of good quality; the grain and coarse fodder should be free from dirt, decay, or a musty condition.

A spirit of kindness toward the stock, exhibited by everyone employed about them, and gentleness of the animals themselves.

Provision for washing and sterilizing or scalding all utensils which come in contact with milk.

Provision for straining, aerating, and cooling the milk in a clean atmosphere, free from all stable and other odors. This treatment should take place immediately after the milk is drawn from each cow.

Facilities for storing the milk and keeping it cold.

Especially great cleanliness in regard to everything connected with the dairy. The atmosphere of the stable should be pure and free from dust when milking is being done. Employees should carefully wipe the udders and wash their hands before milking, and should be in clean clothes. Whitewash is a good disinfectant, and should be seen in many more stables, and land plaster should be sprinkled about to absorb

moisture and odors. The cow should stand on clean litter and not dirty stuff which could be used nowhere else.

If it is suspected that milk is being adulterated a sample might be taken when on the farm. This should be handled as nearly as possible like the daily supply and compared with it as to amount of cream or, better, as to the amount of fat.

If the milk is handled through a store in the city, the building should be kept scrupulously clean, and the room in which the milk is exposed to the atmosphere should be free from dust. There should be provision for keeping the milk cold when stored, and apparatus for steaming or scalding all utensils after they are washed.

TOWN AND CITY MILK SUPPLY.

The average dairy cow gives 350 gallons of milk per year, or about enough to supply 14 persons, provided it is all used as milk. But in all dairy districts more or less butter and cheese are made, and so, within reach of every town or city, there must be at least one cow for about every 12 people. Cows are kept in many villages and in some cities, but the great bulk of milk consumed in cities is produced at some distance from the closely populated section and transported to market by wagons, railroad trains, and boats. Sections are found within easy reach of all cities where dairying is the prominent pursuit and large quantities of milk are produced for shipment. Orange, Dutchess, Sullivan, and Delaware counties are the most important localities near New York City sending milk to that market. Chester County, west of Philadelphia, furnishes that city a large part of its supply. The country west and northwest of Boston furnishes most of its milk. A large part of the supply of Chicago comes from the north, but to the west and south are found excellent dairy lands from which considerable milk is shipped. These dairy sections are famous for their luxuriant pastures, pure cold springs, and fine cattle. In general, these communities are among the most prosperous of the agricultural districts of the country.

CARE OF MILK ON THE FARM.

Whether milk is delivered promptly or held some time before delivery, it needs particular care, and the best dairymen provide for this purpose a room near the stable, but separated from it so as to exclude dust and unpleasant odors. The milk is taken to the milk room as soon as a pail is filled, poured through a fine strainer, and run over a cooling aerator. This apparatus contains cold water, and the milk passes over the outside in a thin sheet. After 20 or 40 quarts have been thus treated a shipping can is filled and set in cold water, or the milk is bottled and kept cold until needed. Some farmers do not use this care, but strain the milk directly into the large can, which stands in any convenient place, usually within the stable. When the can is filled it is placed (as soon as convenient) in a tub of cold water and

stirred until partly cooled, then left with the cover ajar until wanted for delivery. Persons handling milk in this way do not appreciate how sensitive the fluid is to foul surroundings and how quickly it will absorb injurious odors. It is fortunate for consumers that milk shows so plainly when it has been carelessly handled. If purchasers are sufficiently watchful they can avoid being supplied with milk which has been improperly cared for. The dairyman should always bear in mind that milk is a food, and he should not leave it unnecessarily in any place where he would be unwilling to have his own food left an equal length of time.

When milk is served soon after milking, it is frequently not cooled by artificial means, and in small towns supplied by dairymen, who drive in twice each day, it is often delivered "warm from the cow." To many persons this is a guaranty of its purity; but milk served in this way will sour in a short time. Within two or three hours after it is delivered it is likely to be nearer a condition of sourness than milk twelve or twenty-four hours older which was cooled immediately after milking and kept at a low temperature. In some cases the milk delivered in the morning is that of the previous evening, well cooled and kept in a cold place, and the milk delivered in the afternoon is the morning product similarly treated. This is a much better method than the delivery of perfectly fresh warm milk. When but one delivery is made each day, and that in the morning, the production of the same morning and previous evening are usually distributed. Many dairymen do this when they drive directly from the farm to the places of delivery, except when it is necessary to start before the hour of milking; then the milk of the morning and evening of the previous day is taken. During the hottest weather, the evening milk is sometimes delivered by itself early in the morning, and the supply of the same morning is served later.

TRANSPORTATION OF MILK.

Necessarily the milk served in large cities is older than that served in towns and villages, as it has to come from greater distances, and for this reason special care is required in warm weather to prevent souring. The milk is made as cold as possible on the farm and usually held in cold spring water until time to be delivered at the railroad station. If the distance to market is great, a liberal supply of ice is kept on the cars; some railroads provide refrigerator cars. When the milk is not delivered as soon as received in the city, it is stored on ice and is very cold when placed in delivery wagons the next morning. In some cases the morning and previous evening's milk are sent into the city on trains some time during the day. If the distance is not too great and arrival in the city is early enough, the night milk is often served as soon as received, and the morning milk kept for early delivery on the following day. In these cases the city milkman serves milk from twelve to twenty-four hours old; but generally it is older. Railroads entering

some of the large cities carry milk from points two or three hundred miles distant. Their trains usually arrive in the city about midnight and bring milk of the morning and previous evening; it is delivered the following day, being twenty-four or thirty-six hours old when it reaches the consumer. A large part of the supply of New York and some of other cities is the so-called "railroad milk."

The daily receipts in New York city are over 700,000 quarts (including some used in nearby cities), and practically all of this is brought by trains. Philadelphia uses about 300,000 quarts of milk per day, and, being situated in a good dairy country, a considerable part is delivered by wagons directly from the producing farms. Milk carried long distances in refrigerator cars should arrive in the city in as good condition as that which is carried but a short distance. It may seem to some that milk twenty-four or thirty-six hours old is unfit for use; but if it has been carefully handled from the first, it is much better than a supply not so old and not so well cared for. Clean milk that has been cooled as soon as drawn and kept at a low temperature, will change less in two or even three days, and is therefore better, than new milk which has been carelessly handled. Thus it is possible for old milk to be *fresher*, in the usual sense of that term, than new milk.

Milk is usually transported in heavy cans, the most common sizes holding 20, 30, or 40 quarts; the styles in use differ a good deal according to locality. Within the past few years some companies have established bottling stations near their producing farms and transport the milk in jars, which are carried in hot weather packed in cracked ice. This system has many advantages over the use of cans, but is more expensive.

The best conducted milk companies draw their supply regularly from the same dairies and have contracts with the farmers requiring the milk to be produced by healthy cows, strained and cooled immediately, and sent to the city when fresh. Other provisions relate to the care of the dairy and herd, prices, etc. Farmers receive from 2 to 5 cents per quart in different parts of the country. They usually get from 2 to 2½ cents per quart in summer and about 1 cent more in winter. In some localities less than 2 cents per quart is paid the farmer in summer. This low price encourages the keeping of cows which give a large flow of (usually poor) milk and the cheapest possible maintenance.

DELIVERY IN CITIES.

There are as many different ways of delivering milk as there are of producing it, and not an insignificant part of the trouble which it gives is caused by neglect to properly care for it while being delivered. The large wide-mouthed cans which are opened from fifty to a hundred times before they are emptied have their contents thus exposed to considerable dust and dirt. These cans are often carried without ice, even in

the warmest weather, and milk can not possibly remain long in good condition when so treated. An improvement over this method is to have a faucet near the bottom of the can and an arrangement to stir the contents, so that milk of uniform quality can be drawn without exposing the entire supply. In warm weather the cans should be covered with ice or ice water, or at least with a wet blanket, which is some protection.

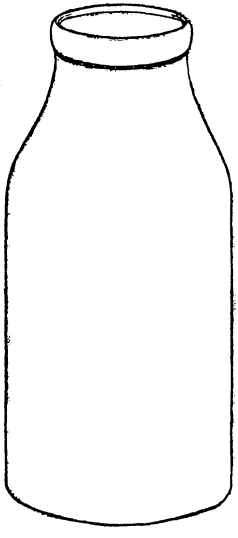

FIG. 8.—Milk jar.

The cleanest and most satisfactory way of delivering milk is in glass jars or bottles (fig. 8). Every person who is served in this way should be certain that the jars are properly cleaned as soon as emptied, and the dealer should clean and sterilize them as soon as they are collected each day. Bottles are easily cleaned, each one is a measure and prevents over or under measuring, and each bottle of milk is known to contain all the cream belonging to it. Bottles do not hide dirt in the milk, and if they are filled with fresh milk and are allowed to stand quietly a few hours cream will usually show at the time of delivery. They save the milk from being unnecessarily exposed, and if they are filled in the country the milk does not come in contact with city air until it is in the house of the consumer. This matter is of considerable importance, as it has been shown that bacteria are very abundant in the atmosphere of cities, while in clean country districts but few are found in the air. The use of sealed bottles decreases the opportunity for adulteration. Some companies serving a high-class trade with milk, for which special claims of purity are made, seal the jars, as soon as they are filled, with paper labels on which the time of milking is stamped, and these must be broken before the jar can be opened. A seal like the following is sometimes used:

M——— FARM MILK CO.
Veterinary and analytical control.
Mar. 3, 6 a. m.
Refuse a broken seal.

This is placed over the stopper and the two ends pasted or otherwise fastened to the sides of the jar. It is an excellent plan, and practically removes all chances of the milk being tampered with by driver or servant, and places all the responsibility on the one who bottles the milk; yet this is not effective unless the seal is so prepared and guarded as to prevent its being removed and replaced, or counterfeited. Objections to bottles are: They are heavy, fragile, and so useful in the kitchen that they are not always promptly returned.

It is extremely difficult to get the last trace of dirt out of milk; some

of the filth is in such fine particles that it will go through fine strainers, and later settle to the bottom of the containing vessel while the cream is rising. This sediment is objectionable and should be kept out in the first place, but its presence is not a good argument against the use of jars. The fresher the milk when bottled the more easily the dirt settles, for the same reason that the fat then rises more easily. There should be no such impurity, but if it is to be present it is better to have it in the bottom of the jar than distributed through the milk and held by its viscosity, as may be the case when the milk is in large cans and stirred frequently to keep the cream evenly mixed in. Sediment is got rid of in some cases by allowing the milk to stand a while in large cans or vats and then drawing it off carefully for bottling. Filters for straining milk are now used with some success.

Large companies or firms handling the milk from many dairies usually arrange to have the supply from every separate dairy served on the same route each day, so there will be as little variation as possible in the quality of the milk served to each customer. Such companies generally have equipment for making butter from their surplus, so there is less temptation for them to serve old milk than if they had no facilities to "work it up." The health of each employee and his family should be carefully watched; some companies board their help to enable them to do this.

The adulterations to which milk is liable have been referred to.

Persons who sell milk should be reliable and know much more about it than many of them do. For this reason it would be well if every dealer were obliged to register at the office of some local official and show that he understands something of the proper production of milk and is able to apply some approved test for fat. The registration of milk dealers is now required in some cities.

The way milk is handled greatly influences its cost to the producer. If the business is carried on in a slipshod way, milk can be sold at a profit for a low price. But the product of a good herd, well fed and cared for, that has received care in all particulars from the moment it came from the cow and perhaps is served in expensive glass jars, should command a fair price. The extra cost of good stock and buildings, reliable help, the best feed, veterinary and chemical supervision, and superior methods of delivery is considerable, and all will admit that milk produced with such aids is much more desirable and worth more than that produced and handled in a careless manner.

IMPROVEMENTS SUGGESTED.

Other things being equal, the price of milk should depend on its quality. It is most unreasonable for milk containing but 3 per cent of fat to sell for the same price per quart as 5 per cent milk. Many regard all milk as the same, and are satisfied as long as it is sweet and cheap; they are unwilling to pay more for one quality than another.

This is just the same as it would be to expect to purchase sirloin steak for the price of round, or the finest of flour for the price of a poorer quality. Four quarts of good milk may contain as much food value as 5 quarts of poor milk, and as it costs more to produce a rich than a poor milk, it is right that it should sell for more. If the practice of paying for milk according to its quality were adopted, it might give an opportunity to peddlers of imposing on customers by giving them a lower grade of milk than they pay for, but the evil would be no greater than exists at present. This could be avoided by following some such method of delivery as is in use in parts of France and Germany. Taps connecting with the different cans in the wagon project from the wagon sides, and above each is a plain sign stating what kind of milk comes from it. Thus each customer can see exactly what he gets, and it is safe to allow the peddlers to carry different grades. Such a plan, in connection with rigid inspection and penalties for fraud, would be a great improvement over the present system.

The grades of milk should be numbered with the whole numbers nearest to the percentage of fat content. Thus a separator skim milk with but a trace of fat would be "0." Skim milk having from one-half to 1½ per cent of fat would be "1," and so on. Whole milk would be of three grades, "3," "4," and "5," and extra rich or "fortified" milk (to which cream has been added) would be "9" or "10." Cream would run from "13" to "50." No more grades of milk and cream need to be carried than is the custom now, but each should be marked with its appropriate number. While the idea of the percentage of fat thus indicated might not be clear to all, it would soon be understood that the higher numbers meant the richer milk. If this practice were observed it would be difficult for the drivers to tell their customers one thing and the milk inspector another about the quality of the contents of the same can. The signs should be so attached to the wagon side or can that they could not be easily changed. If bottles were used the number representing the quality should be attached to each one.

One thing which adds greatly to the expense of delivering milk in cities is the long distance that has to be traveled to serve a small amount of milk. Sometimes every house in a block is served by a different peddler, and yet all get practically the same kind of milk. This condition can not be easily changed while competition is so strong; but it would be a long step toward reformation and economy in the milk business if consumers and peddlers would cooperate so as to avoid this useless waste of labor.

FARMERS' BULLETINS.

These bulletins are sent free of charge to any address upon application to the Secretary of Agriculture, Washington, D. C. Only the following are available for distribution:

No. 15. Some Destructive Potato Diseases: What They Are and How to Prevent Them. Pp. 8.
No. 16. Leguminous Plants for Green Manuring and for Feeding. Pp. 24.
No. 18. Forage Plants for the South. Pp. 30.
No. 19. Important Insecticides: Directions for Their Preparation and Use. Pp. 20.
No. 21. Barnyard Manure. Pp. 32.
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No. 38. Spraying for Fruit Diseases. Pp. 12.
No. 39. Onion Culture. Pp. 31.
No. 40. Farm Drainage. Pp. 24.
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